4.14 ENERGY

This section assesses the impact of the SR-22/West Orange County Connection project alternatives on transportation-related energy consumption in the study corridor for year 2020. The analysis estimated the total amount of energy expected to be consumed by each of the alternatives. Both direct (operational) energy and indirect (construction) energy impacts were assessed. (Note: Because the models used for calculating energy use are only in English units, such as British thermal units and miles, this discussion is only in English units. The results, however, are also converted into metric units.)

Direct energy consumption involves energy used by the operation of vehicles. In assessing the direct energy impact, consideration was given to the following factors:

- Vehicle mix, including light-duty vehicles (LDV), medium trucks (MT), and heavy trucks (HT)
- Annual VMT
- Variation of fuel consumption rates by vehicle type

The direct energy analysis for each alternative was based on projected year 2020 corridor traffic volumes and total VMT. The 2020 daily traffic volumes for the study corridor were obtained from the traffic analysis contained in Section 4.7. The daily VMT was annualized using a factor of 335 days/year. The VMT Fuel Consumption Method utilized for this project is outlined in the *Energy and Transportation Systems* manual (Caltrans, 1983). Energy consumption factors for the various modes identified in Table 4.14-1 were developed by Oak Ridge Laboratory and published in the 1996 *Transportation Energy Book: Edition 16.*[1]

Table 4.14-1
ENERGY CONSUMPTION FACTORS

Mode	Factor
Passenger Vehicles (auto, van, light truck)	6,233 BTU[a]/Vehicle Mile
Heavy Truck	22,046 BTU/Vehicle Mile
Transit Bus (all vehicle types)	41,655 BTU/Vehicle Mile
Rail (light or heavy)	77,739 BTU/Vehicle Mile
Commuter Rail (Metrolink)	100,000 BTU/Vehicle Mile

Source: Oak Ridge Laboratory, 1996
Note:[a] BTU= British Thermal Unit, equal to the amount of heat required to raise one pound of water one degree Fahrenheit at one atmosphere of pressure

Indirect, or construction energy effects involve the one-time, non-recoverable energy costs associated with construction of roadways, structures, and vehicles. The indirect energy analysis was conducted using the Input-Output Method. This method converts either VMT or 2000 construction dollars into energy consumption based on existing data of other roadway improvement projects in the U.S. utilizing the conversions listed in Table 4.14-2.

Utilizing the annual direct energy savings and the energy consumed for construction, a payback period was calculated. The energy payback period is the amount of time it takes to recover the quantity of energy expended for the construction of a project. The energy payback period is determined by dividing the construction energy by the annual operational energy savings due to the project (see example below).

<u>Example Alternative</u>
Construction Energy / Operational Energy Savings (Example Alternative - No Build) = Payback Period
240,000 barrels of oil /31,000 barrels of oil = 7.7 years

If the project would use more operational energy than the No Build Alternative, there is no annual energy savings compared to the No Build Alternative and the payback period would never be met. A payback

[1] Both these publications are available at Caltrans, District 12.

period of under five years is considered an excellent investment while a payback period of greater than 20 years will generally be beyond the foreseeable future of the project (Caltrans, 1983).

Table 4.14-2
CONSTRUCTION ENERGY CONSUMPTION FACTORS

Mode	Factor
Construction	
Automobiles and Trucks (manufacturing)	1,410 BTUs/Vehicle Mile[a]
Bus (manufacturing)	3,470 BTUs Vehicle Mile[a]
Roadway (construction)	27,500 BTUs/1977$[a,b]
Electrical (TSM Elements)	4,688 BTUs/1982$[a,b]
Maintenance	
Automobiles and Trucks	1,400 BTUs/Vehicle Mile[a]
Bus	13,142 BTUs/Vehicle Mile[a]

Source: [a] Caltrans, 1983
Note: [b] 2001$ converted to 1977$ and 1982$

Both direct and indirect energy consumption is measured in British thermal units (BTUs). One BTU is the quantity of energy necessary to raise one pound of water one degree Fahrenheit at one atmosphere of pressure. BTUs have been converted to the equivalent barrels of crude oil for comparison of alternatives.

4.14.1 Direct Energy (Operational)

In the energy analysis, potential energy consumption of each alternative is compared to the No Build condition rather than existing conditions. The annual direct energy consumption for each alternative is summarized in Table 4.14-3, and is discussed below.

A. NO BUILD ALTERNATIVE

Under the No Build Alternative, the annual VMT for automobiles and trucks within the corridor is forecast to be 3.36 billion miles in 2020. Given the VMT and vehicle fuel consumption on an annual basis, vehicles operating within the corridor are anticipated to expend approximately 24,800 billion BTUs or about 891 million liters (4.28 million barrels) of crude oil. Overall, the No Build Alternative would result in moderate energy consumption. This is primarily due to the additional 20 million annual VMT this alternative has over the Build Alternative.

B. TSM/EXPANDED BUS SERVICE ALTERNATIVE

The TSM/Expanded Bus Service Alternative would have a higher VMT than the No Build, Full Build, or Reduced Build Alternative, mostly as a result of the expanded bus service. The VMT for this alternative would be approximately 3.38 billion miles in 2020. With this VMT, the energy consumption would be approximately 25,020 billion BTUs or about 897 million liters (4.31 million barrels) of oil. This alternative would have the second highest energy consumption of any of the alternatives.

C. FULL BUILD ALTERNATIVE

Under the Full Build Alternative, 2020 VMT for automobiles and trucks within the corridor is forecast to be 3.34 billion miles in 2020. Vehicles operating within the corridor are anticipated to expend approximately 24,680 billion BTUs or about 885 million liters (4.26 million barrels) of oil. Overall, the Full Build Alternative would result in a reduction of energy consumption compared to any of the other alternatives. It is assumed that the time savings provided by HOV direct connectors and more direct access provided by the Pacific Electric arterial would reduce overall corridor VMT. On an annual basis, this alternative would consume approximately 5.6 million less liters (26,700 less barrels) of oil than the No Build Alternative.

Table 4.14-3
ANNUAL 2020 DIRECT ENERGY CONSUMPTION

Description	Alternative			
	No Build	**TSM/Expanded Bus Service**	**Full Build**	**Reduced Build**
Vehicle Miles Traveled				
Light-duty Vehicles	3,202,164,098	3,225,591,961	3,182,196,517	3,288,482,985
Heavy Trucks	94,181,297	94,870,352	93,594,015	96,720,088
Buses	67,272,355	67,764,537	66,852,868	69,085,777
BTUs Consumed[a]				
Light-duty Vehicles (billions)	19,959	20,105	19,834	20,497
Heavy Trucks (billions)	2,076	2,092	2,063	2,132
Buses (billions)	2,802	2,823	2,785	2,878
Total BTUs Consumed (billions)	**24,838**	**25,019**	**24,683**	**25,507**
Total Barrels of Oil Consumed	**4,282,350**	**4,313,680**	**4,255,650**	**4,397,790**
Total Liters of Oil Consumed	**890,728,800**	**897,245,440**	**885,175,200**	**914,740,320**
Change in BTUs vs. No Build (billions)	**---**	**182**	**-155**	**670**
Change in Barrels vs. No Build	**---**	**31,330**	**-26,700**	**115,440**
Change in Liters vs. No Build	**---**	**6,516,640**	**-5,553,600**	**24,011,520**

Source: [a] Oak Ridge National Laboratory, 1996

D. REDUCED BUILD ALTERNATIVE

Under the Reduced Build Alternative, 2020 VMT for automobiles and trucks within the corridor is forecast to be 3.45 billion miles, the most of any of the alternatives. The increased VMT over the No Build and Full Build Alternatives would result from an increase in the number of vehicles desiring to use SR-22 (added capacity would be an attraction to the facility), additional buses operating within the corridor, and a less direct route to downtown Santa Ana (no Pacific Electric arterial). Vehicles operating within the corridor are anticipated to expend approximately 25,500 billion BTUs or about 915 million liters (4.40 million barrels) of oil. Overall, the Reduced Build Alternative would result in the highest energy consumption for all alternatives. On an annual basis, this alternative would consume approximately 24 million more liters (115,440 more barrels) of oil than the No Build Alternative.

Thresholds of Significance for CEQA:

- Impacts to energy consumption

A. NO BUILD ALTERNATIVE

This alternative is used as the baseline for comparison for all other alternatives. Predicted energy consumption in the 2020 for the No Build Alternative would be about 891 million liters (4.28 million barrels) of crude oil. This alternative is anticipated to have no significant impact on energy consumption.

B. TSM/EXPANDED BUS SERVICE ALTERNATIVE

This alternative would have the second highest energy consumption among the alternatives under study with a consumption of about 897 million liters (4.31 million barrels) of oil. However, this alternative is anticipated to have no significant impact on energy consumption.

C. FULL BUILD ALTERNATIVE

Overall, the Full Build Alternative would result in a reduction of energy consumption compared to any of the other alternatives primarily due to travel time savings. This alternative is anticipated to have no significant impact on energy consumption.

D. REDUCED BUILD ALTERNATIVE

the Reduced Build Alternative would result in the highest energy consumption for all alternatives. On an annual basis, this alternative would consume approximately 24 million more liters (115,440 more barrels) of oil than the No Build Alternative. This alternative is anticipated to have no significant impact on energy consumption.

4.14.2 Indirect Energy (Construction)

The indirect energy consumption for each alternative is summarized in Table 4.14-4 and is discussed below.

A. NO BUILD ALTERNATIVE

There would be no construction costs, beyond vehicle manufacturing, associated with the No Build Alternative. The only indirect energy associated with the No Build Alternative would be the manufacturing and maintenance of vehicles within the study corridor. Automobile and bus manufacturing and maintenance would consume approximately 10,380 billion BTUs or about 372 million liters (1.79 million barrels) of crude oil. This alternative would consume the least amount of indirect energy.

Table 4.14-4
INDIRECT ENERGY CONSUMPTION

Description	Alternatives			
	No Build	**TSM/ Expanded Bus Service**	**Full Build**	**Reduced Build**
Construction				
Corridor Annual VMT	*3,363,617,750.00*	*3,388,226,850.00*	*3,342,643,400.00*	*3,454,288,850.00*
Vehicles - Auto Mfg.[a] (BTUs)	4,647,847,006,950	4,681,851,861,330	4,618,864,650,120	4,773,136,332,930
Vehicles - Bus[a] (BTUs)	233,435,071,850	235,142,943,390	231,979,451,960	239,727,646,190
Roadway[a] (BTUs)			5,397,591,054,313	3,634,601,485,149
Electrical (TSM)[a] (BTUs)		120,719,744,409	120,719,744,409	120,719,744,409
Subtotal BTUs	*4,881,282,078,800*	*5,037,714,549,129*	*10,369,154,900,802*	*8,768,185,208,627*
Subtotal Barrels of Oil	*841,600*	*868,571*	*1,787,785*	*1,511,756*
Maintenance				
Auto Maintenance[a] (BTUs)	4,614,883,553,000	4,648,647,238,200	4,586,106,744,800	4,739,284,302,200
Bus Maintenance[a] (BTUs)	884,093,289,410	890,561,545,254	878,580,391,256	907,925,281,334
Subtotal BTUs	*5,498,976,842,410*	*5,539,208,783,454*	*5,464,687,136,056*	*5,647,209,583,534*
Subtotal Barrels of Oil	*948,099*	*955,036*	*942,187*	*973,657*
TOTAL BTUs	**10,380,258,921,210**	**10,576,923,332,583**	**15,833,842,036,858**	**14,415,394,792,212**
TOTAL BARRELS OF OIL	**1,789,700**	**1,823,607**	**2,729,973**	**2,485,413**
TOTAL LITERS	**372,257,600**	**379,310,256**	**567,834,384**	**516,965,904**
DIRECT ENERGY SAVINGS	**N/A**	**no savings**	**26,700 barrels (5,553,600 liters)**	**no savings**
PAYBACK PERIOD	**N/A**	**N/A**	**102.2 years**	**N/A**

Sources: [a] Caltrans, 1983

B. TSM/EXPANDED BUS SERVICE ALTERNATIVE

Construction costs associated with this alternative would be primarily for signal synchronization/controller upgrades, automated response plan, highway advisory radio, changeable message signs, fleet management system, and transit intersection priority system. Indirect energy associated with these systems in addition to manufacturing and maintenance of vehicles would be approximately 10,577 billion BTUs or about 379 million liters (1.82 million barrels) of crude oil. As shown in Table 4.14-3, there would be no direct energy savings associated with this alternative. As a result, there would be no energy savings to payback construction and maintenance costs as shown in Table 4.14-4.

C. FULL BUILD ALTERNATIVE

As shown in Table 4.14-4, structures and roadway construction costs would substantially add to the indirect energy consumed, while vehicle manufacturing would be similar to other alternatives. The indirect energy associated with construction of the Full Build Alternative would be approximately 10,369 billion BTUs or about 1,787,785 barrels of oil. Maintenance of vehicles within the study corridor would be similar to the other alternatives and consume approximately 5,465 billion BTUs or about 942,190 barrels of crude oil. Overall energy consumption would be the second highest of all alternatives, consuming approximately 15,834 billion BTUs or approximately 568 million liters (2.73 million barrels) of oil. As shown in Table 4.14-4, there would be an energy savings of approximately 5.6 million liters (26,700 barrels of oil) annually. With this direct energy savings, and an overall indirect expenditure of 2.73 million barrels of oil, it would take approximately 102.2 years to payback the construction and maintenance energy, as shown in Table 4.14-4. This would be beyond the foreseeable life of the facility.

D. REDUCED BUILD ALTERNATIVE

Like the Full Build Alternative, structures and roadway construction costs of the Reduced Build Alternative would be the largest element of the indirect energy. The total indirect energy associated with construction of the Reduced Build Alternative would be slightly higher than the Full Build Alternative at approximately 8,768 billion BTUs or about 1,511,756 barrels of oil. Maintenance of vehicles within the study corridor would also be slightly higher than the other alternatives and consume approximately 5,647 billion BTUs or about 973,660 barrels of crude oil. Overall energy consumption would be higher than the Full Build Alternative consuming approximately 14,415 billion BTUs or approximately 517 million liters (2.49 million barrels) of oil. As shown in Table 4.14-4, there would be no direct energy savings associated with this alternative. As a result, there would be no energy savings to payback construction and maintenance costs.

4.14.3 Mitigation

No operational mitigation measures are required for the Full Build Alternative because this alternative would result in a net savings in direct energy consumption. Due to the higher overall VMT associated with either the TSM/Expanded Bus Service or Reduced Build Alternatives, measures would have to be implemented to reduce the VMT to below the No Build Alternative and to provide savings in direct energy. The impacts on energy usage would be small, however, so mitigation is not required.

Further improvements in the energy efficiency would require an increase in HOV lane usage (if available) and transit ridership through measures such as:

- Expanded marketing programs
- Increased connectivity of the transit system serving the area
- Improved patron access to station areas via expanded feeder service, pedestrian amenities, convenient parking, and facilities supporting other non-motorized modes of station access

4.14.4 Residual Impacts After Mitigation

A. NO BUILD

None.

B. TSM/EXPANDED BUS SERVICE

Less than substantial.

C. FULL BUILD ALTERNATIVE

None.

D. REDUCED BUILD ALTERNATIVE

Less than substantial.

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